

WHAT IS CLAIMED IS:

1. A pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma, which comprises in combination:
 - (a) an electrically insulating hollow tube open at one end and having a wall;
 - (b) a grounded metallic electrode piercing the wall of said hollow tube;
 - (c) a second metallic electrode piercing the wall of said hollow tube in the vicinity of said grounded electrode;
 - (d) means for flowing a gas in which the species is entrapped through said hollow tube;
 - 10 (e) a high voltage dc pulse generator in electrical contact with said second electrode for generating a pulsed plasma in the gas flowing between said grounded electrode and said second electrode; and
 - (f) an optical spectrometer for spectrally resolving and detecting the light emission exiting the open end of said hollow tube characteristic of the species entrapped in the gas.
- 15 2. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, wherein the light emission from the species comprises molecular light emission.
3. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, wherein said grounded electrode and said second electrode are disposed in opposition to one another.
4. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, wherein said grounded electrode and said second electrode are both substantially planar electrodes disposed parallel to each other.

5. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, wherein the flowing gas is selected from the group consisting of helium, argon, nitrogen and air.
6. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, wherein the species comprise organic molecules.
7. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, wherein the high voltage pulse generator produces a pulsed voltage of between 0.3 keV and 5 keV between said grounded electrode and said second electrode.
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8. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 7, wherein the pulsed voltage is applied to the gas for between 30 and 300 μ s.
9. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 7, wherein the average electrical power applied to the gas is between 0.02 W and 5 W.
10. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, wherein said hollow tube comprises plastic tubing.
11. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, wherein the region where said ground electrode and said second electrode pierce said hollow tube is sealed using a sealant to prevent leakage of the flowing gas from said hollow tube.

12. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, further comprising an optically transparent window for sealing the open end of said hollow tube, thereby preventing back-diffusion of ambient air into said hollow tube.
13. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 1, wherein the gas in which the species is entrapped derives from the output of a vapor phase chromatograph.
14. A pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma which comprises in combination:
 - (a) an electrically insulating hollow tube open at one end and having a wall;
 - (b) a grounded metallic electrode piercing the wall of said hollow tube;
 - (c) a second metallic electrode piercing the wall of said hollow tube in the vicinity of said grounded electrode;
 - (d) means for flowing a gas in which the species is entrapped through said hollow tube;
 - (e) means for generating a dc pulsed plasma in the gas flowing between said grounded electrode and said second electrode; and
 - (f) means for spectrally resolving and detecting light emission exiting the open end of said hollow tube characteristic of the species entrapped in the gas.
15. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein the light emission from the species comprises molecular light emission.
16. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein said grounded electrode and said second electrode are disposed in opposition to one another.

17. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 16, wherein said grounded electrode and said second electrode are both substantially planar electrodes disposed parallel to each other.
18. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein the flowing gas is selected from the group consisting of helium, argon, nitrogen and air.
19. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein the species comprise organic molecules.
20. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein the high voltage pulse generator produces a pulsed voltage of between 0.3 keV and 5 keV between said grounded electrode and said second electrode.
21. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 20, wherein the pulsed voltage is applied to the gas for between 30 and 300 μ s.
22. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 20, wherein the average electrical power applied to the gas is between 0.02 W and 5 W.
23. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein said hollow tube comprises plastic tubing.

24. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein the region where said ground electrode and said second electrode pierce said hollow tube is sealed using a sealant to prevent leakage of the flowing gas from said hollow tube.
25. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, further comprising an optically transparent window for sealing the open end of said hollow tube, thereby preventing back-diffusion of ambient air into said hollow tube.
26. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein the gas in which the species is entrapped derives from the output of a vapor phase chromatograph.
27. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein said means for spectrally resolving and detecting light emission from the species entrapped comprises an optical spectrometer.
28. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of species in the plasma as described in claim 14, wherein said means for generating a pulsed plasma comprises a high voltage dc pulse generator in electrical contact with said second electrode.
29. A pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma which comprises the steps of:
 - (a) flowing a gas containing the species through an insulating hollow tube open at one end;
 - (b) generating a pulsed plasma between a grounded electrode and a second electrode disposed in the electrically insulating hollow tube by

applying a pulsed dc voltage to the second electrode, whereby the species are excited; and

(c) spectrally resolving and detecting light emission exiting the hollow tube from the open end thereof.

30. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 29, wherein the light emission from the species comprises molecular light emission.
31. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 29, wherein said grounded electrode and said second electrode are disposed in opposition to one another.
32. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 31, wherein said grounded electrode and said second electrode are both substantially planar electrodes disposed parallel to each other.
33. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 29, wherein the flowing gas is selected from the group consisting of helium, argon, nitrogen and air.
34. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 29, wherein the species comprise organic molecules.
35. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 29, wherein the pulsed plasma is generated by applying a pulsed voltage of between 0.3 keV and 5 keV between the grounded electrode and the second electrode.

36. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 35, wherein the pulsed voltage is applied to the gas for between 30 and 300 μ s.
37. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 35, wherein the average electrical power used to generate the plasma is between 0.02 W and 5 W.
38. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 29, wherein the hollow tube comprises plastic tubing.
39. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 29, wherein an optically transparent window is used for sealing the open end of the hollow tube, thereby preventing back-diffusion of ambient air into the hollow tube.
40. The pulsed, atmospheric pressure plasma method for generating and analyzing light emission characteristic of species in the plasma as described in claim 29, wherein the gas in which the species is entrapped derives from the output of a vapor phase chromatograph.
41. A pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma which comprises in combination:
 - (a) an electrically insulating hollow tube open at one end and having a wall;
 - (b) a grounded metallic electrode piercing the wall of said hollow tube;
 - (c) a second metallic electrode piercing the wall of said hollow tube in the vicinity of said grounded electrode, wherein said grounded electrode and said second electrode are both substantially planar electrodes disposed parallel to each other;
 - (d) means for flowing a gas in which the organic species is entrapped through said hollow tube;

- (e) a high voltage dc pulse generator in electrical contact with said second electrode for generating a pulsed plasma in the gas flowing between said grounded electrode and said second electrode; and
 - (f) an optical spectrometer for spectrally resolving and detecting the light emission exiting the open end of said hollow tube characteristic of the organic species entrapped in the gas.
42. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma as described in claim 41, wherein the light emission from the species comprises molecular light emission.
43. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma as described in claim 41, wherein the flowing gas is selected from the group consisting of helium, argon, nitrogen and air.
44. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma as described in claim 41, wherein the high voltage pulse generator produces a pulsed voltage of between 0.3 keV and 5 keV between said grounded electrode and said second electrode.
45. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma as described in claim 44, wherein the pulsed voltage is applied to the gas for between 30 and 300 μ s.
46. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma as described in claim 44, wherein the average electrical power applied to the gas is between 0.02 W and 5 W.
47. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma as described in claim 41, wherein said hollow tube comprises plastic tubing.

48. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma as described in claim 41, wherein the region where said ground electrode and said second electrode pierce said hollow tube is sealed using a sealant to prevent leakage of the flowing gas from said hollow tube.
49. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma as described in claim 41, further comprising an optically transparent window for sealing the open end of said hollow tube, thereby preventing back-diffusion of ambient air into said hollow tube.
50. The pulsed, atmospheric pressure plasma apparatus for generating and analyzing light emission characteristic of organic species in the plasma as described in claim 41, wherein the gas in which the species is entrapped derives from the output of a vapor phase chromatograph.